RECYCLING WHEY FOR PROFITABLE USES

STRICTLY INTERPRETED THE TITLE OF THIS ARTICLE could mean feeding of whey back to the cow. Experimental work is showing this can be done but it is a low profit, emergency measure of whey disposal. A better solution is one which will recover, for human food, the whey half of our milk solids. The whey story is a familiar one. For centuries we have fed it to pigs or dumped it. Whey has also been used as a medicine.

In 1761, Dr. F. Hoffman, physician to the King of Prussia, published a "Treatise on the Virtues and Uses of Whey." He said, "There are few fluids more salutary, and better adapted to prevent, and cure, the diseases of the human body than whey." Again, "The ancients likewise attributed uncommon virtues to whey in removing obstructions in the vessels of the bowels, and other parts, whence terrible disorders not only in the head but also in the belly have their origin." Dr. Hoffman often used whey as a laxative. Its effectiveness for this purpose may be attributed to what we now call "lactose intolerance."

We can no longer pollute our waterways with 22 billion pounds of whey every year. But after 30 years of searching, we have found uses for only half of whey production. The remainder must be constructively utilized before this decade passes.

Dried whey for animal feed is worth about four to five cents per pound or about its cost of production. It can be upgraded for feed by fermentation, by additives, or by showing that it contains valuable growth factors other than its protein and carbohydrate. More research is needed to take full advantage of the potential of whey feed although some 70 per cent of whey utilized already goes into animal feeds. What we will discuss now is how we can recycle whey back into the food chain.

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Whey in Food Products

In looking for a place for whey in food, emphasis should be on the unique properties of its three basic components, lactose, protein, and salts. Uses for lactose are increasing, largely because of vigorous promotion by one or two manufacturers. But we are in urgent need of more uses because most of the whey processing costs must be borne by the lactose. Whey protein is nutritionally one of the best proteins known. Its unique properties should be exploited to better advantage. Its value varies greatly depending upon purity and extent of denaturation. Whey or milk salts are thus far without much commercial worth except as they are sold as part of a whey product or a prepared mix. The quantities of these components in whey are shown in Table I.

Whey is a perishable commodity and must be processed at once after it is removed from the cheese curd. Figure 1 shows the common processes and these are applicable to both sweet and acid whey.

Pasteurization to stop bacterial growth is always the first step. This may be followed by one or more of the following: Concentration, fermentation, fractionation, and, finally, to stabilize the product for commercial use, dehydration. Only fractionation is a newcomer to this group of processes. There is much interest in preparation of protein and lactose fractions from whey by heat coagulation, electrodialysis, ultrafiltration or gel filtration. Each process results in a varying degree of concentration of lactose and protein in the resulting two fractions. Costs rise as the purity of the lactose fraction or the protein fraction is increased. Food preparations containing up to 80 per cent undenatured whey protein find specialty uses in food manufacture that justify their higher cost.

The least expensive method for separating protein from whey is by heat coagulation and this is often done as a step in clarifying whey for lactose manufacture. The denatured protein is dried and used mostly for animal feed.

Fractions high in undenatured protein can be obtained by electrodialysis and various membrane filtra-

FRACTIONATION OF WHEY PROCESSES AND PRODUCTS

PROCESS	PRODUCT
Heat Coagulation	Denatured whey protein Lactose
Electrodialysis	Low ash whey protein Lactose
Ultrafiltration	High protein whey High lactose permeate
Gel filtration	Concentrates up to 80% protein Lactose

TABLE I
COMPOSITION OF CHEESE WHEY

COMPONENT	SWEET CHEDDAR WHEY		ACID COTTAGE WHEY	
	FLUID	DRIED	FLUID	DRIED
Lactose	5.0	72.0	4.7	66.5
Protein	0.9	13.0	0.9	13.0
Ash	0.56	8.0	.6	8.6
Fat	.07	1.0	—	—
Lactic Acid	.15	2.0	.6	8.6
Water	93.2	4.0	93.2	3.3
pH	6.3	5.9	4.7	4.3

tion procedures. The lactic acid in cottage cheese whey goes largely with the lactose fraction, but most of the preparations that have been made are derived from sweet cheese whey. The composition of some experimental high protein products made in the Dairy Products Laboratory, USDA, are shown in Table II. Membrane filtration is the preferred and less expensive method for reaching 65 per cent protein, but gel filtration of the membrane filtered product yields still higher protein concentrations.

The composition of some high whey protein industrial products is shown in Table III. Most of them are made by proprietary processes based on earlier electrodialysis or later membrane and gel filtration procedures. Concentration is expensive and the higher protein concentrates must be used in food applications that justify higher costs. The protein in the products listed in Table III is worth up to one dollar per pound of protein.

Protein Quality

Protein quality measured by available lysine reflects nutritional value and effectiveness of processing. Excessive heat during manufacture of whey products promotes the browning reaction which indicates the degree of lysine cross-linking that makes this amino acid unavailable to man and animals. The values of Table IV (from the work of Pallansch and associates in 1971, in the Dairy Products Laboratory) show the per cent of total lysine that is available in several dried whey protein preparations. Worthy of note is the reduced lysine content of the roller-dried whey as compared to the spray product. Reduction of heat exposure of roller powder would improve its lysine availability.

Cottage cheese whey can be foam-spray-dried but the condition of the lactose in the powder affects its hydroscopicity. Completely amorphous lactose causes the powder to be highly hydroscopic and to cake in storage after moisture absorption. To avoid this, the cottage cheese whey should be concentrated to 50 per cent or higher solids, the lactose crystallized, and the resulting heavy slurry spray-dried. Some further crystallization can be accomplished during the drying process while there is still moisture in the powder particle. An advantage of the foam-spray process is that injection of air expands the particles, making them easier to dry. Thus, concentrates of higher solids can be dried by the foam-spray process rather than by conventional procedures. This means more lactose can be crystallized in the concentrate which also contains less water. While comparative data are lacking, it is estimated that a 50 per cent solids cottage cheese whey can be foam-spray dried as easily as one of 40 per cent solids when air is not injected at the spray. Furthermore, almost two times as much lactose (about 24 per cent of the total at room temperature) can be crystallized before drying in the 50 per cent concentrate as in the 40 per cent whey. Most of the uncrystallized lactose in the spray feed must be crystallized during drying if a non-hydroscopic powder is to be obtained.

TABLE II
COMPOSITION OF SOME HIGH WHEY PROTEIN PRODUCTS FROM EMN RESEARCH

Product	Protein	Lactose	Ash	Fat	Moisture
1. Membrane Filtration	35.	52.	6.	—	4.
1. Membrane Filtration recycled 2 — 90% removals	64.9	28.5	1.7	—	4.
3. Membrane + Gel Filtration	69.2	19.0	2.2	—	4.
4. NaHMP + Gel Filtration	78.7	2.9	13.7	—	1.9

TABLE III
COMPOSITION OF SOME HIGH WHEY PROTEIN INDUSTRIAL PRODUCTS

Product	Protein	Lactose	Ash	Fat	Moisture
1. Membrane Filtration (Miles Labs.)	55.6	27.2	3.7	0.9	5.3
2. Gel & RO/UF (Energ Process)	75.2	5.8	11.8	1.2	2.3
3. Electrodialysis (Purity Cheese Co.)	28.	51.	10.	1.3	4.
4. Electrodialysis (Foretein-Foremost Foods)	35.	54.	3.	3.	5.
5. Lactalbumin Complex (Whey protein concentration of Borden, Inc.)	59.0	19.0	13.3	6.2	2.5

TABLE IV
TOTAL AND AVAILABLE LYSINE IN HIGH PROTEIN WHEY POWDERS MADE BY DIFFERENT PROCESSES

	% Protein	Total Lysine Chromotographic g/100 g protein	% Total Lysine Available
Native Whey Protein	100.	11.4	100.0
Gel Filtration & Spray Dried	87.84	11.34	85.7
Ultra Filtration Gel Filtration & Spray Dried	80.04	10.54	93.3
Gel Filtration HMP & Spray Dried	78.67	10.91	80.4
Roller Dried Whey	12.70	5.98	77.8
Spray Dried Whey	12.46	10.44	86.4

Dried Cottage Cheese Whey

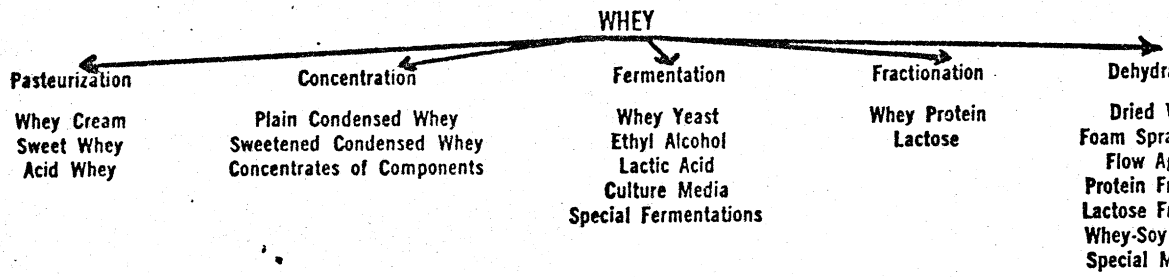
The presence of about eight per cent lactic acid in dried cottage cheese whey makes this whey uniquely suited as a source of acid and whey solids in acidified foods. Some of these appear in Table V, such as fruit or tomato juices, sour dough and rye breads, sherbets and popsicles. More specialized uses will be needed to provide a market for the increasing quantities of cottage cheese whey that must be dried in the future. Acid whey can also be used in non-acid foods by removing or buffering the acid. Acid, salts, and lactose are partially separated in membrane filtration processes. But this adds to costs and further limits markets.

The uses for sweet whey shown in Table V have been gradually developed during the last 30 years. Whey has replaced nonfat milk in many foods because of its lower cost. Twenty-five per cent of the nonfat milk solids in ice cream mix can be derived from whey. Whey produces a tender, cake-like texture in sweet bakery goods. The lactose in whey, when crystallized, in fudge, makes a desirable fine-grained structure. Whey has long been

TABLE V
SOME USES FOR WHEY IN FOODS

BEVERAGES:	Fruit Juices (Rivella) Cola Drinks (pH < 4) Vegetable Juices (Tomato) Soups (Cream of Tomato)
BAKERY PRODUCTS:	Cake, Cookies, Crackers Sour Dough and Rye Bread Prepared Mixes Breading Mix for Fried Foods Pie Crust and Fillings
MEAT PRODUCTS:	Meat Loaves and Spreads Sausage and Frankfurters
DAIRY PRODUCTS:	Ice Cream, Sherbet and "Popsicles" Process Cheese and Cheese Spreads Cream Sauces Modified Milk
CONFECTIONS:	Fudge, Caramel, Fondants

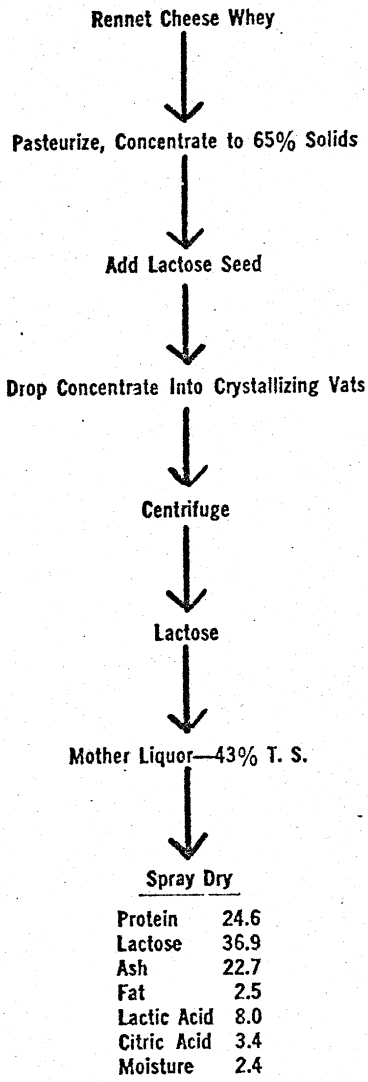
FIGURE 1
PROCESSES FOR RECYCLING WHEY INTO THE FOOD CHAIN



an important ingredient in processed cheese foods. Whey appears on the ingredient statements of dozens of packaged foods and prepared mixes on the shelves on our supermarkets. In these, it furnishes a top-grade protein, with milk minerals and lactose to accentuate desirable flavor and give a smooth, full-bodied mouth feel and texture.

Today's market for dried whey is not as well established as that for dried nonfat milk. This is especially true for dry whey protein or lactose fractions and for various blends of whey and skim milk or whey and soy. Whey-soy products have special merit since the soy can replace the casein removed in cheesemaking. Manufacturers of these products usually find it necessary to actively promote markets for them.

CONCENTRATION OF WHEY PROTEIN IN THE MOTHER LIQUOR FROM LACTOSE MANUFACTURE*



Protein	24.6
Lactose	36.9
Ash	22.7
Fat	2.5
Lactic Acid	8.0
Citric Acid	3.4
Moisture	2.4

*From Nickerson, T. A., "Byproducts From Milk, 1970, edited by B. H. Webb and E. O. Whittier, AVI Publishing Co., Westport, Conn.

"Milk Can Be Sold" Is Theme Of California Conference

"Milk *Can* Be Sold" were the opening words used by Gordon B. Reuhl, manager of the California Milk Advisory Board at two special Milk Sales Conferences held for state sales, advertising and promotion executives within the dairy industry. The two events were held recently in Los Angeles and Oakland.

Designed to inform the dairy industry of California of the magnitude and scope of the non-brand milk promotional program of Milk Advisory Board, the conferences also were aimed at building new understanding and belief in milk, showing that milk *can* be sold effectively despite competition and public issues.

Keynote speaker at the conferences was Dr. Gaylord P. Whitlock, Director of Family and Consumer Sciences, University of California, using the subject "Is Milk Worth Selling?" Whitlock stated that no other industry has a product superior to milk, and that milk is needed in the diets of all normal, healthy persons, young and old. The nutritional leader told conference attendees of the unmatched qualities of milk and dairy foods, and asked industry leaders "to sell milk in the Seventies, rather than other products, for milk has everything going for it."

A review of the Milk Advisory Board initial program of advertising and promotion, launched in March of 1970, indicated that after a four year decline in total Class I sales, the downward trend was halted by the end of 1970. Consumer buying habits and likes and dislikes relating to dairy foods were covered, with such information being used to establish effective, motivating programs of consumer advertising.